UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

May 3, 1999

(b) (6)
[redacted]

As requested, I am enclosing excerpts from reports related to the investigation at the Rodale Manufacturing Supefund Site (Site). Y(b) (6)
[redacted]

If you have any questions regarding the information enclosed or you have any questions regarding the investigation for this site, do not hesitate to contact me at 215-814-3199.

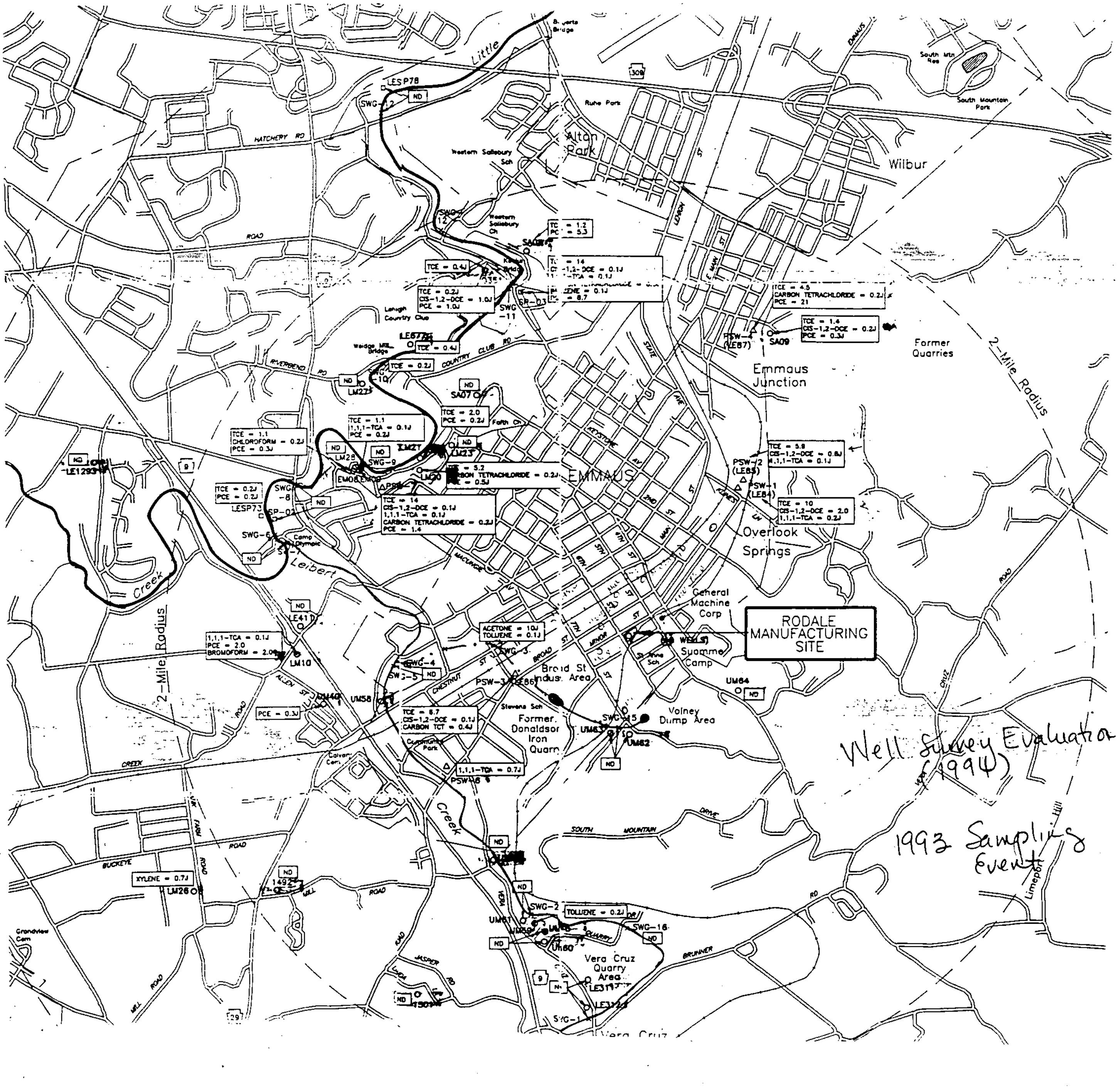
Sincerely,

Maria de los A. Garcia
Remedial Project Manager

Enclosure

cc: Anthony Dappolone, EPA
Hollis Scoggin, EPA
Ron Schock, PADEP


(b) (6)


RODALE MANUFACTURING SITE
EMMAUS
Alton Park
Wilbur
Emmaus Junction
Overlook Springs
Former Quarries
2-Mile Radius
General Machine Corp
Suamme Camp
Volney Dump Area
Broad St Indus. Area
Former Donaldson Iron Quarry
Vera Cruz Quarry Area
Little Lehigh Creek
Leibert Creek
South Mountain Park
Lehigh Country Club
Well Survey Evaluation (1994)
1993 Sampling Event

Well Survey Evaluation Report (1994)

5.0 DISCUSSION AND CONCLUSIONS

A well survey and associated sampling tasks were conducted in the vicinity of the Rodale Manufacturing site in Emmaus, Pennsylvania. The objectives of the well survey activity were to characterize groundwater, surface water and stream sediment quality in the study area to help determine the environmental effects from activities at the Rodale site and other potential sources of contamination on these media. Historically, groundwater contamination by volatile organic compounds (VOCs) has been documented at several public and private wells within the study area, including the Rodale site. Because groundwater contamination by VOCs is of a regional nature, it is likely that a number of potential sources exist in the area. For purposes of the well survey activity, the study area was defined as that area within a three-mile radius (not separated by a groundwater flow divide) of the Rodale site, and included the Borough of Emmaus and parts of Lower Macungie, Upper Milford, Salisbury and Upper Saucon Townships (Plate 1).

To meet the objectives of the study, the following four primary activities were conducted:

1. *Identification of Water Supply Providers*
2. *Well and Surface Water Evaluation*
3. *Groundwater, Surface Water and Stream Sediment Sampling*
4. *Groundwater Elevation Contouring*

A brief description and the results of each of these items is described as follows:

5.1 Identification of Public Water Providers

The identification of public water providers and the approximate extent of service was conducted within the study area. The Borough of Emmaus provides groundwater to all residents within Borough boundaries (Figure 1-4), and to additional connections in Upper Milford and Salisbury Townships, located south and northeast of the Borough, respectively. The Borough utilizes six groundwater production wells (PSW-1, PSW-2, PSW-3, PSW-4, PSW-6 and PSW-7, Plate 1); water is filtered and chlorinated prior to distribution. Water from PSW-1, PSW-2, and PSW-7 is treated with an air-stripper to remove VOCs; an air stripper is being installed at PSW-4.

Significant portions of Lower Macungie and Salisbury Township, located northwest of the Borough, are served by Lehigh County Authority (LCA). LCA reportedly utilizes 14 production wells to provide service to more than 7,000 customers. Salisbury and Upper Saucon Townships reportedly receive water from the nearby cities of Allentown and Bethlehem. Most portions of Upper Milford Township, as well as some areas within the other townships, are not served by public water and therefore can be assumed to rely on private wells.

5.2 Well and Surface Water Evaluation

The identification of groundwater users in the study area was conducted based on well logs and other information obtained from several sources, including USGS and PADER files, appropriate geologic reports, discussions with municipal officials, and a field survey (see Table 2-1). Based on these sources, over 350 wells were identified in the study area and information was compiled into a database. The well record search was subject to the limitations described in Section 2.4.3.

This information was evaluated to select appropriate groundwater sampling locations. In addition, an assessment was also conducted of the primary watercourses, seeps and springs in the study area. Information from the surface water assessment was also entered into a database and evaluated to select appropriate sample locations.

5.3 Groundwater, Surface Water and Stream Sediment Sampling

An assessment of groundwater quality in the study area included collection and laboratory analysis of samples from 10 onsite wells, 6 Borough of Emmaus water supply wells, and 31 private wells. In addition, 13 surface water, 4 spring, and 14 stream sediment samples were collected. The primary findings for each parameter type are as follows:

5.3.1 Volatile Organic Compounds

Onsite Wells

Groundwater at the Rodale site is impacted (found above MCLs) with six primary VOCs at the indicated concentration ranges:

1. Trichloroethene (TCE, 97 to 180,000 ppb)

2. 1,2-Dichloroethene (1,2-DCE, 310 to 43,000 ppb)

3. Vinyl Chloride (VC, 150 to 3,200 ppb)

4. Tetrachloroethene PCE, (3 to 3,900 ppb)

5. 1,1,2-Trichloroethane (1,1,2-TCA, 9 to 270 ppb)

6. 1,1-Dichloroethene (1,1-DCE, 27 ppb in one well)

VOC concentrations are highest for all VOCs in onsite disposal wells (Wells 1, 2 and 3). Concentrations have decreased at most wells since the previous round of sampling conducted by EPA in 1989. Of these six VOCs, only three (TCE, 1,2-DCE, and PCE) were found in offsite monitor wells MW-2, MW-3 or MW-4 at concentrations above MCLs.

Offsite Wells

VOCs were detected at concentrations above or near MCLs in five of the six Borough of Emmaus water supply wells:

1. **PSW-1.** TCE was detected at a concentration of 10 ppb;

2. **PSW-2.** TCE was detected at a concentration of 5.9 ppb;

3. **PSW-3.** TCE was detected at a concentration of 6.7 ppb;

4. **PSW-4.** PCE and TCE were detected at concentrations of 21/19 and 4.5/4.4 ppb, respectively, and;

5. **PSW-7** TCE was detected at a concentration of 14 ppb.

These concentrations are consistent with the results from the quarterly monitoring for VOCs conducted by the Borough per PADER requirements.

Of the 31 private wells and 4 springs, VOCs were found above MCLs at only 3 locations:

1. Well **LM-20**, Orchid Place in Lower Macungie Township. At this location, TCE was found at a concentration of 5.2 ppb.

2. Well **SA-08**, Keystone Road, Salisbury Township. At this location, PCE was detected at a concentration of 5.3 ppb.

3. Spring **SP-03**, Keystone Road, Salisbury Township (adjacent to SA-08 location above). At this spring, which is used for residential supply, PCE and TCE were found at concentrations of 14 and 8.7 ppb, respectively.

Based on these water quality results and groundwater flow information summarized in Section 4.0, the following observations are made:

- The concentration of PCE in Borough of Emmaus well PSW-4, which is located more than one mile northeast (and cross-gradient) of the Rodale site, is higher than any other location in the study area. The SA-08 and SP-03 locations, where PCE was also found, are generally downgradient of PSW-4. These data suggest that additional sources of contamination may be present in that portion of the study area.

- Based on data for an aquifer pumping (yield) test conducted at PSW-4 in September 1991, the Liethsville Formation is a very prolific aquifer. This well was pumped at a rate of 900 gpm for 48 hours, and the <u>total</u> drawdown measured was 1.85 feet, which corresponded to a calculated transmissivity of 792,000 gallons per day per foot (gpd/ft).

Based on this value, a routine calculation was made to estimate the zone of influence (capture zone) of PSW-4. The boundary of the capture zone can be estimated using the following equation (from Todd, 1980, page 122):

$$2Y_L = Q/2Ti$$

where:

Y = coordinate location of capture boundary (well assumed to be located at X = 0 and Y = 0 with direction of flow parallel to X-axis); the capture zone width is $2Y_L$

Q = discharge rate of well

T = transmissivity of aquifer

i = horizontal hydraulic head gradient

This equation is based on the assumptions of a uniform flow field.

For this calculation, the following input parameter values were used:

Q = 900 gpm (pumping rate during aquifer test; this rate is greater than the daily average pumping rate of 300-350 gpm [see Table 1-3], and therefore results in a more conservative capture zone estimate)

T = 792,000 gallons per day/ft (based on results of Borough's aquifer test at PSW-4)

i = 0.028 ft/ft (average horizontal hydraulic head gradient based on water level measurements collected by GEC [see section 4.2.3])

Substituting these values yields the following estimate for the capture zone:

$2Y_L$ = 2 [(900 gal/min)(1440 min/day)]/ [2(792,000 gal/day*ft)(0.028 ft/ft)]
= 60 feet

Based on this estimate, it appears unlikely that pumping from PSW-4 will induce the flow of contaminants in groundwater from the Rodale site.

- Borough of Emmaus wells PSW-1 and PSW-2 are located more than one-half mile east, and hydraulically cross-gradient from, the Rodale site. It is possible that another source(s) of VOCs is present in that portion of the study area. Furthermore, while VOC concentrations decrease in the side gradient (northwesterly) direction from the site toward PSW-1/PSW-2, concentrations then increase in a northwesterly direction between PSW-1/PSW-2 and PSW-4 (a distance of 0.75 mile).

- Borough well PSW-3 is located approximately one-half mile from, and hydraulically cross-gradient to, the Rodale site. PSW-3 is located close to the Broad Street industrial area (see Plate 2), where several former and existing industrial operations are located.

- The remaining wells where VOCs were found above MCLs (PSW-7 and LM-20) are close to Little Lehigh Creek, which is the primary groundwater discharge zone in the study area. VOCs in these wells may have originated at a number of possible upgradient sources.

- VOCs were not found above MCLs at any of the four wells (LE-1293, LM-27, LE-677, and 0351) sampled on the north side of Little Lehigh Creek. These data suggest that groundwater with VOCs above MCLs are not migrating beyond the creek to northern portions of the study area. Available literature states that groundwater and surface water are connected within the Little Lehigh Creek basin, and that groundwater contributes approximately 80 percent of baseflow in this region (Sloto, 1991). For these reasons, Little Lehigh Creek likely represents the groundwater discharge boundary in the area.

- VOCs were not found above MCLs in any of the six wells (UM-43, UM-45,UM-59, UM-60, UM-61, and LE-312) sampled in the vicinity of the Vera Cruz/Quarry Road site in Upper Milford Township.

Surface Water

VOCs were not found above quantitation limit in any surface water samples from the study area.

Springs

As stated above, PCE and TCE were found in spring sample SP-03 at concentrations above MCLs. VOCs were not detected in the remaining three spring samples from the study area.

Stream Sediment

No VOCs were detected in stream sediment samples, with the exception of 4-methyl-2-pentanone (4 J ppb) in SD-2, acetone (290 J ppb) and toluene (8 J ppb) in SD-9D, and several VOCs at very low concentrations marked with a "B" (blank) designation. Results for these three VOCs appear to be anomalous and do not suggest any patterns or sources of contamination.

5.3.2 Semi-Volatile Organic Compounds

Onsite Wells

Several semivolatile organic compounds (SVCs) were detected at concentrations up to 6,000 ppb. The largest number of SVCs were found in Well 5 (the shallow cistern approximately 8 feet in depth), and are likely attributed to localized soil contamination. It is significant to note that SVCs were not found above quantitation limits at offsite monitor wells MW-2 through MW-4.

Borough of Emmaus Wells

SVCs were also not found above quantitation limits in any of the Emmaus water supply wells that were sampled. Based on these data, it appears that SVCs are confined to the Rodale site.

5.3.3 TAL Total and Dissolved Metals and Cyanide

Onsite Wells

MCLs were exceeded in some onsite wells for **total** (unfiltered) analysis of the following: beryllium (1 well), cadmium (4 wells), lead (6 wells), nickel (1 well) and cyanide (1 well). For the **dissolved** (filtered) analysis, however, concentrations were below MCLs for all these parameters.

These data indicate that the site is not contributing dissolved metals or cyanide at levels that exceed MCLs. An evaluation of these concentrations versus risk-based concentrations will be made during later stages of the RI/FS process, as necessary (i.e., the Risk Assessment). The possibility of total metals migration as colloidal particles cannot be dismissed, however, and will be further evaluated in upcoming sampling events.

Offsite Wells

Results of analyses for TAL total and dissolved metals and cyanide in offsite (Borough of Emmaus and private) wells indicate that only one sample displayed an MCL exceedance: UM-61, with a total lead concentration in the investigative and duplicate sample of 231 and 25.8 ppb, respectively. The dissolved lead concentration, however, was below detection limit. It is important to note that this residence utilizes a whole-house filter for incoming water from the well (the sample was collected from an in-line sample tap prior to the filter); this concentration is expected to be silt-related and not indicative of any regional water quality problem for lead. No other wells in the area reveal elevated lead concentrations.

Surface Water

Results of analyses for TAL total and dissolved metals and cyanide in surface water samples indicate that no samples displayed MCL exceedances.

Calcium and magnesium concentrations generally increase along downgradient stretches of Liebert and Little Lehigh Creek, suggesting that significant groundwater discharge is occurring in these areas (since groundwater typically has elevated calcium and magnesium concentrations relative to surface water).

Stream Sediment

Results of analyses for TAL metals and cyanide in stream sediment samples indicate that low concentrations (2 - 10 ppb) of arsenic were detected in all samples. Chromium concentrations above 24 ppb, and zinc concentration above 75 ppb, were detected in all samples from the south intermittent tributary and at two locations in Little Lehigh Creek. Concentrations of some metals (chromium, lead, nickel, and zinc) in SD-10 were high relative to other samples.

Since metals and cyanide were not found above MCLs in groundwater and surface water (with the exception noted above), it is unnecessary to closely compare results from sediment samples.

5.3.4 General Water Quality Parameters

Results of analyses for general water quality parameters indicate that nitrates are present above MCLs in monitor wells MW-1 (16 ppm) and MW-2 (12/13 ppm). The source of nitrates is unknown. In addition, low pH conditions (below 5 standard units) were found to exist at MW-1 (4.47), MW-2 (4.71) and MW-3 (4.59).

5.4 Groundwater Elevation Contouring

Measurement of water levels was conducted at available, surveyed onsite wells, Borough of Emmaus water supply wells, private wells and surface water gauges to assess groundwater flow conditions at the site and in the study area. Based on these measurements, the following statements can be made:

- Groundwater flow at the site is generally to the northwest at a horizontal hydraulic-head gradient of 0.006 ft/ft or 32 feet per mile (see Figure 4-1).

- Groundwater flow in the study area was also determined to be to the northwest (see Plate 2). This determination is consistent with that observed at the site and reported in the literature (Wood, 1972, and Sloto, 1991). The horizontal hydraulic-head gradient was found to vary from the southern portion of the study area to the northern portion, and appears to be proportional to the topography.

- Little Lehigh Creek appears to be the primary groundwater discharge feature in the study area. Several springs and a steep streambed gradient of 0.0022 ft/ft or 12 feet per mile were observed along Little Lehigh Creek within the study area.

TABLE 3-11 - SUMMARY OF POSITIVE (DETECTED) RESULTS FOR VOLATILE ORGANIC COMPOUNDS IN PRIVATE WELL SAMPLES (PAGE 4 OF 5)

Location ID:		SA-08		LM-28	LE-312	LE-411	LM-21		SA-09	UM-62
Sample List No.:		81*		80*	66	45	51		58, Alt. 1	69, Alt. 2
GEC Sample No.:		PW-SA08	PW-SA08D	PW-LM28	PW-LE312	PW-LE411	PW-LM21	PW-LM21D	PW-SA09	PW-UM62
EPA Sample No:		SA08-	SA08D	LM28-	LE312	LE411	LM21-	LM21D	SA09-	UM62-
Sample Type:		INV	DUP	INV	INV	INV	INV	DUP	INV	INV
Sample Date:		8/11/93	8/11/93	8/11/93	8/12/93	8/12/93	8/12/93	8/12/93	8/12/93	8/12/93
Compounds:	**MCL (ppb)**	**CONCENTRATION (µg/l or ppb)**								
Acetone	--								1.9 B	2.8 B
Carbon Disulfide	--				0.7 B				0.4 B	0.1 B
Methylene Chloride	5	0.9 B	0.3 B	0.5 B	0.6 B	1.6 B	0.5 B	1.6 B	0.7 B	
cis-1,2-Dichloroethene	70								0.2 J	
2-Butanone	--	9.8 L		8.7 L						
Chloroform	100						0.2 B	0.1 B	0.1 B	
1,1,1-Trichloroethane	200									
Carbon Tetrachloride	5									
Trichloroethene	5	1.2	1.2				2.0	1.8	1.4	
Toluene	1000									
Tetrachloroethene	5	4.9	5.3				0.2 J	0.2 J	0.3	
Xylene	10000									
Bromoform	100									

TABLE 3-11 - SUMMARY OF POSITIVE (DETECTED) RESULTS FOR VOLATILE ORGANIC COMPOUNDS IN PRIVATE WELL SAMPLES (PAGE 3 OF 5)

Location ID:		LM-23		SA-07	LM-20	LM-26	UM-60	UM-61		LM-27
Sample List No.:		53		55, Alt. 1	50	68, Alt. 3	75, Alt. 2	76, Alternate 1		48, Alt. 2
GEC Sample No.:		PW-LM23	PW-LM23D	PW-SA07	PW-LM20	PW-LM26	PW-UM60	PW-UM61	PW-EM61D	PW-LM27
EPA Sample No:		LM23-	LM23D	SA07-	LM20-	LM26-	UM60-	UM61-	UM61D	LM27-
Sample Type:		INV	DUP	INV	INV	INV	INV	INV	DUP	INV
Sample Date:		8/9/93	8/9/93	8/10/93	8/10/93	8/10/93	8/10/93	8/10/93	8/10/93	8/11/93
Compounds:	**MCL (ppb)**	**CONCENTRATION (µg/l or ppb)**								
Acetone	--	1.6 B			12 L					
Carbon Disulfide	--			0.1 B	0.4 B					
Methylene Chloride	5	0.4 B	0.4 B	0.2 B	1.0 B		0.4 B	0.6 B	0.2 B	0.9 B
cis-1,2-Dichloroethene	70									
2-Butanone	--									12 L
Chloroform	100				0.3 B		0.5 B			
1,1,1-Trichloroethane	200									
Carbon Tetrachloride	5				0.2 J					
Trichloroethene	5				5.2					
Toluene	1000									
Tetrachloroethene	5				0.5 J					
Xylene	10000					0.7 J				
Bromoform	100									

TABLE 3-11 - SUMMARY OF POSITIVE (DETECTED) RESULTS FOR VOLATILE ORGANIC COMPOUNDS IN PRIVATE WELL SAMPLES (PAGE 2 OF 5)

Location ID:		LE-677		1492	SA-05	0351	LE-1293	UM-40	EM-08	EM-09
Sample List No.:		46		62	60	42	44	71	40	41
GEC Sample No.:		LE677	LE677D	PW-1492	PW-SA05	PW-0351	PW-LE1293	PW-UM40	PW-EM08	PW-EM09
EPA Sample No:		LE677	LE67D	1492-	SA05-	0351-	1293-	UM40-	EM08-	EM09-
Sample Type:		INV	DUP	INV	INV	INV	INV	INV	INV	INV
Sample Date:		8/5/93	8/5/93	8/5/93	8/5/93	8/5/93	8/5/93	8/4/93	8/9/93	8/9/93
Compounds:	**MCL (ppb)**	**CONCENTRATION (µg/l or ppb)**								
Acetone	--							9.6 L		0.6 B
Carbon Disulfide	--							0.2 B	0.4 B	
Methylene Chloride	5	0.5 B	0.4 B	0.4 B	0.4 B	0.3 B	0.8 B	0.8 B		0.3 B
cis-1,2-Dichloroethene	70									
2-Butanone	--									
Chloroform	--								0.2 J	0.1 B
1,1,1-Trichloroethane	200				0.5 J					0.1 J
Carbon Tetrachloride	5									
Trichloroethene	5	0.4 J	0.4 J			0.4 J			1.1	1.1
Toluene	1000									
Tetrachloroethene	5							0.3 J	0.3 J	0.2 J
Xylene	1000									
Bromoform	100				0.2 J					

TABLE 3-11 - SUMMARY OF POSITIVE (DETECTED) RESULTS FOR VOLATILE ORGANIC COMPOUNDS IN PRIVATE WELL SAMPLES (PAGE 1 OF 5)

Location ID:		UM-43	UM-58		1501	LM-10	LE-311	UM-45		UM-59
Sample List No.:		72	79		63	47	39	73		74, Alt. 1
GEC Sample No.:		PW-UM43	PW-UM58	PW-UM58D	PW-1501	PW-LM10	PW-LE311	PW-UM45	PW-UM45D	PW-UM59
EPA Sample No:		UM43-	UM58-	UM58D	1501-	LM10-	LE311	UM49-	UM49D	UM59-
Sample Type:		INV	INV	DUP	INV	INV	INV	INV	DUP	INV
Sample Date:		8/3/93	8/3/93	8/3/93	8/3/93	8/3/93	8/4/93	8/4/93	8/4/93	8/4/93
Compounds:	**MCL (ppb)**	**CONCENTRATION (µg/l or ppb)**								
Acetone	--			0.6 B						8.9 L
Carbon Dislufide	--									
Methylene Chloride	5	0.5 B	0.6 B	0.7 B	0.7 B		0.4 B	0.6 B	0.5 B	1.5 B
cis-1,2-Dichloroethene	70									
2-Butanone	L									
Chloroform	100									
1,1,1-Trichloroethane	200					0.1 J				
Carbon Tetrachloride	5									
Trichloroethene	5									
Toluene	1000									0.2 J
Tetrachloroethene	5					2.0				
Xylene	10000									
Bromoform	100					2.0				

TABLE 3-13 SUMMARY OF RESULTS FOR ANALYSIS OF TAL DISSOLVED METALS IN PRIVATE WELLS (PAGE 4 OF 5)										
Location ID:		**SA-08**		**LM-28**	**LE-312**	**LE-411**	**LM-21**		**SA-09**	**UM-62**
Sample List No.:		81*		80*	66	45	51		58, Alt. 1	69, Alt. 2
GEC Sample No.:		PW-SA08	PW-SA08D	PW-LM28	PW-LE312	PW-LE411	PW-LM21	PW-LM21D	PW-SA09	PW-UM62
EPA Sample No:		SA08F	A08DF	LM28F	E312F	E411F	LM21F	M21DF	SA09F	UM62F
Sample Type:		INV	DUP	INV	INV	INV	INV	DUP	INV	INV
Sample Date:		8/11/93	8/11/93	8/11/93	8/12/93	8/12/93	8/12/93	8/12/93	8/12/93	8/12/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	233 J	32.5 U	32.5 U
Antimony	6	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL
Arsenic	50	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Barium	2000	43.9 R	23.4	32.2	79.6	87.8	44.4	43.4	21.0 B	11.2 B
Beryllium	4	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U
Cadmium	5	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Calcium	--	35400	34600	72800	2860	60400	66700	65700	25100	5660
Chromium	100	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U
Cobalt	--	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U
Copper	1,300#	4.4 UL	4.4 UL	4.4 UL	76.8 B	4.4 UL	18.7 B	18.2 B	4.4 UL	151
Iron	--	4.9 U	4.9 U	4.9 U	4.9 U	4.9 U	16.7 B	298 J	14.3 B	54.7 B
Lead	15	0.5 U	0.5 U	0.5 UL	0.57	0.5 UL	10.1	8.2	0.5 U	0.5 U
Magnesium	--	22200	22200	31700	538 B	42400	43400	43200	15700	4600
Manganese	--	2.8	1.9 U	6.2	1.9 U	8.2	7.9	7.2	4.0 B	15.0 B
Mercury	2	0.06 U	0.06 B	0.1 B	0.08 B	0.1 B	0.1 B	0.13 B	0.15 B	0.07 B
Nickel	100	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U
Potassium	--	1830 L	1960	4460	2350	5180	2310	2290	2000 B	736 B
Selenium	50	0.9 UL	0.9 UL	0.9 UL	0.9 UL	0.9 UL	0.9 UL	0.9 UL	0.90 UL	0.90 U
Silver	--	3.1 U	9.6 J	3.1 U	3.1 U	24.1 K	3.1 U	3.1 U	3.1 U	3.1 U
Sodium	--	7070	6470	31900	8060	97400	33300	32800	3220	4990
Thallium	2	3.5 B	3.7 B	4.1 B	3.0 B	4.7 B	3.9 B	4.4 B	4.3 B	4.2 B
Vanadium	--	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL
Zinc	N	6.5 B	6.5 U	12.0 B	14.5 B	56.2	19.9 B	20.1 B	8.4 B	22.2 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-13 SUMMARY OF RESULTS FOR ANALYSIS OF TAL DISSOLVED METALS IN PRIVATE WELLS (PAGE 3 OF 5)										
Location ID:		**LM-23**		**SA-07**	**LM-20**	**LM-26**	**UM-60**	**UM-61**		**LM-27**
Sample List No.:		53		55, Alt. 1	50	68, Alt. 3	75, Alt. 2	76, Alternate 1		48, Alt. 2
GEC Sample No.:		PW-LM23	PW-LM23D	PW-SA07	PW-LM20	PW-LM26	PW-UM60	PW-UM61	PW-UM61D	PW-LM27
EPA Sample No:		LM23F	M23DF	SA07F	LM20F	LM26F	UM60F	UM61F	M61DF	LM27F
Sample Type:		INV	DUP	INV	INV	INV	INV	INV	DUP	INV
Sample Date:		8/09/93	8/09/93	8/10/93	8/10/93	8/10/93	8/10/93	8/10/93	8/10/93	8/11/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U
Antimony	6	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL
Arsenic	50	1.4 B	1.7 B	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.9	1.2 U
Barium	2000	29.3	30.2	10.2	29.3	46.8	43.9	5.4	6.3	1.8 U
Beryllium	4	0.36 B	0.48 B	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U
Cadmium	5	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Calcium	--	65400	64100	10400	49800	35000	50100	25800	25100	754
Chromium	100	5.5 U	5.5 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U
Cobalt	--	2.8 U	2.8 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U
Copper	1,300#	6.2 U	6.2 U	17.2 B	10.0 B	14.6 B	4.4 U	4.4 UL	4.4 UL	4.4 UL
Iron	--	9.7 U	9.7 U	4.9 U	4.9 U	4.9 U	5.7 B	16.1 B	15.4 B	4.9 U
Lead	15	0.86 B	1.1 B	0.71 L	0.52 L	1.4 L	0.60 L	0.50 U	0.50 U	0.50 UL
Magnesium	--	39400	38400	22700	33100	22800	29100	17300	17200	369 B
Manganese	--	1.2 UL	1.2 UL	1.9 U	3.6	2.9	3.5 B	17.2	18.3	1.9 U
Mercury	2	0.06 U	0.06 U	0.06 B	0.06 U	0.06 U	0.06 U	0.06 B	0.06 B	0.06 B
Nickel	100	4.3 U	4.3 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U
Potassium	--	1340	1450	14700	1430 L	2970 L	2410 L	1640	1590	365
Selenium	50	4.5 U	4.5 U	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL
Silver	--	6.9 U	6.9 U	3.1 U	181 R	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U
Sodium	--	27800	27500	117000	9040	6190	10700	4190	4160	99600
Thallium	2	1.9 B	1.9 U	4.8 B	3.9 B	4.0 B	4.7 B	3.6 B	3.4 B	3.7 B
Vanadium	--	3.7 U	3.7 U	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL	2.0 UL
Zinc	N	16.4 B	19.8 B	22.1 B	9.7 B	17.7 B	26.6 B	8.6 B	13.4 B	10.0 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-13 SUMMARY OF RESULTS FOR ANALYSIS OF TAL DISSOLVED METALS IN PRIVATE WELLS (PAGE 2 OF 5)										
Location ID:		LE-677		1492	SA-05	O351	LE-1293	UM-40	EM-08	EM-09
Sample List No.:		46		62	60	42	44	71	40	41
GEC Sample No.:		LE677	LE677D	PW-1492	PW-SA05	PW-0351	PW-LE1293	PW-UM40	PW-EMO8	PW-EM09
EPA Sample No:		LE67F	LE67DF	1492F	SA05F	0351F	1293F	UM40F	EM08F	EM09F
Sample Type:		INV	DUP	INV	INV	INV	INV	INV	INV	INV
Sample Date:		8/05/93	8/05/93	8/05/93	8/05/93	8/05/93	8/05/93	8/04/93	8/09/93	8/09/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U
Antimony	6	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL
Arsenic	50	1.2 U	1.2 U	1.2 U	1.2 U	1.6 B	1.4 B	1.2 U	1.2 U	1.2 U
Barium	2000	21.7	21.3	87.4	62.1	23.5	21.3	18.6	20.0	24.0
Beryllium	4	0.30 U	0.3 U	0.3 U	0.96 B	0.3 U	0.3 U	0.3 U	0.30 U	0.36 B
Cadmium	5	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Calcium	--	33800	34500	13900	9830	36600	39700	36700	58700	52500
Chromium	100	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U
Cobalt	--	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U
Copper	1,300#	6.2 U	6.2 U	16.2 B	6.2 U	6.2 U	6.2 U	6.2 U	6.2 U	11.4 B
Iron	--	9.7 U	9.7 U	9.7 U	20.4 B	9.7 U	18.7 B	22.6 B	9.7 U	9.7 U
Lead	15	0.50 U	0.50 U	0.5 U	0.5 U	1.4 B	0.5 U	0.65 B	0.84 B	0.74 B
Magnesium	--	19200	19500	8860	4320	20500	22900	25100	28800	25900
Manganese	--	1.2 UL	1.2 UL	1.2 UL	269	1.3 L	1.2 UL	1.2 UL	1.2 UL	1.2 UL
Mercury	2	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Nickel	100	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U
Potassium	--	1720	1750	1260	1190	1680	1870	2020	2270	2230
Selenium	50	0.90 U	0.90 U	0.9 U	0.9 U	0.9 UL	0.9 UL	0.9 UL	0.90 UL	0.9 U
Silver	--	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U
Sodium	--	5500	5630	9130	14700	5960	4280	2960	11500	10700
Thallium	2	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Vanadium	--	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U
Zinc	N	17.3 B	18.0 B	19.5 B	30.6 B	355	23.5 B	13.5 B	28.3 B	20.6 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-13 SUMMARY OF RESULTS FOR ANALYSIS OF TAL DISSOLVED METALS IN PRIVATE WELLS (PAGE 1 OF 5)

Location ID:		UM-43	UM-58		1501	LM-10	LE-311	UM-45		UM-59
Sample List No.:		72	79		63	47	39	73		74, Alt. 1
GEC Sample No.:		PW-UM43	PW-UM58	PW-UM58D	PW-1501	PW-LM10	PW-LE311	PW-UM45	PW-UM45D	PW-UM59
EPA Sample No:		UM43F	UM58F	U58DF	1501F	LM10F	E311F	UM49F	U49DF	UM59F
Sample Type:		INV	INV	DUP	INV	INV	INV	INV	DUP	INV
Sample Date:		8/03/93	8/03/93	8/03/93	8/03/93	8/03/93	8/04/93	8/04/93	8/04/93	8/04/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U	32.5 U
Antimony	6	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL	14.1 UL
Arsenic	50	2.6 B	3.2 B	2.0 B	2.4 B	1.2 U	1.2 U	3.5 B	1.5 B	1.7 B
Barium	2000	165	26.6	27.1	7.1	23.1	198	6.2	7.1	32.8
Beryllium	4	0.3 U	0.3 U	0.3 U	0.48 B	0.30 U	0.30 U	0.3 U	0.3 U	0.3 U
Cadmium	5	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Calcium	--	41400	45500	47200	9620	30000	17000	23400	23400	32300
Chromium	100	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U
Cobalt	--	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U
Copper	1,300#	6.2 U	6.7 B	6.2 U	105	12.7 B	61.4	6.2 U	6.2 U	14.8 B
Iron	--	118	12.8 B	9.7 U	9.7 U	11.0 B	38.6 B	9.7 U	19.4 B	9.7 U
Lead	15	0.5 U	0.5 U	0.5 U	0.5 B	0.50 U	0.50 U	0.5 U	0.5 U	0.5 U
Magnesium	--	13200	26100	27000	7550	18300	8240	15700	15600	18900
Manganese	--	27.5 L	1.2 UL	1.2 UL	20.7 L	1.2 UL	69.7	4.5 L	4.2 L	1.2 UL
Mercury	2	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Nickel	100	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	8.3	4.3 U	4.3 U	4.3 U
Potassium	--	2840	2580	2550	1440	2050	4390	1660	1650	1780
Selenium	50	0.9 UL	0.9 UL	0.9 UL	0.92	0.90 UL	0.90 U	0.9 U	0.9 U	1.2 L
Silver	--	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U
Sodium	--	8920	20900	21700	9240	5980	10700	3910	4010	5080
Thallium	2	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Vanadium	--	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U
Zinc	N	6.0 B	37.5 B	37.0 B	19.6 B	8.2 B	4390	9.8 B	24.8 B	8.0 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-12 SUMMARY OF RESULTS FOR ANALYSIS OF TAL TOTAL M.. ..LS IN PRIVATE WELLS (PAGE 5 OF 5)

Location ID:		UM-63	UM-64	
Sample List No.:		82*	83*	
GEC Sample No.:		PW-UM63	PW-UM64	PW-UM64D
EPA Sample No:		UM63-	UM64-	UM64D
Sample Type:		INV	INV	DUP
Sample Date:		8/25/93	8/25/93	8/25/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**		
Aluminum	N	13.6 UL	13.6 UL	13.6 UL
Antimony	6	9.2 U	9.2 U	9.2 U
Arsenic	50	2.1 B	3.2 B	2.0 B
Barium	2000	63.0	47.3	47.3
Beryllium	4	0.6 U	0.6 U	0.6 U
Cadmium	5	2.0 U	2.0 U	2.0 U
Calcium	--	13000	33700	33500
Chromium	100	5.5 U	5.5 U	5.5 U
Cobalt	--	2.8 U	2.8 U	2.8 U
Copper	1,300#	25.3	32.5	33.5
Iron	--	196 L	697 J	543 J
Lead	15	2.5 B	7.5	9.0
Magnesium	--	6910	18800	18700
Manganese	--	8.8 B	12.5 B	11.3 B
Mercury	2	0.06 U	0.08 B	0.07 B
Nickel	100	4.4 U	4.4 U	4.4 U
Potassium	--	2140	2110	2110
Selenium	50	1.2 L	0.90 UL	0.90 UL
Silver	--	3.1 U	3.1 U	3.1 U
Sodium	--	7980	9620	9560
Thallium	2	1.9 U	1.9 U	1.9 U
Vanadium	--	2.0 U	2.0 U	2.0 U
Zinc	N	132	14.8 B	12.1 B
Cyanide	200	2.5 U	2.5 U	2.5 U

NOTES: MCL = Maximum Contaminant Level (EPA, April 1992); N = listed, no MCL assigned; (--) = no MCL assigned
= MCLG (MCL goal) for copper; INV = Investigative; DUP = Duplicate
Data Qualifiers: U = not detected at stated detection limit; UL = biased low detection limit; J = estimated value;
L = biased low result; K = biased high result; B = detected in blank

TABLE 3-12 SUMMARY OF RESULTS FOR ANALYSIS OF TAL TOTAL METALS IN PRIVATE WELLS (PAGE 4 OF 5)

Location ID:		SA-08		LM-28	LE-312	LE-411	LM-21		SA-09	UM-62
Sample List No.:		81*		80*	66	45	51		58, Alt. 1	69, Alt. 2
GEC Sample No.:		PW-SA08	PW-SA08D	PW-LM28	PW-LE312	PW-LE411	PW-LM21	PW-LM21D	PW-SA09	PW-UM62
EPA Sample No:		SA08-	SA08D	LM28-	LE312	LE411	LM21-	LM21D	SA09-	UM62-
Sample Type:		INV	DUP	INV	INV	INV	INV	DUP	INV	INV
Sample Date:		8/11/93	8/11/93	8/11/93	8/12/93	8/12/93	8/12/93	8/12/93	8/12/93	8/12/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	13.6 U	13.6 U	1070	27.6	13.6 U	13.6 U	13.6 U	13.6 U	13.6 U
Antimony	6	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	9.2 U	9.6 B
Arsenic	50	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Barium	2000	24.9 B	24.9 B	48.1	81.2	77.4	39.0	40.3	19.3	11.2
Beryllium	4	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.60 U	0.78 B
Cadmium	5	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.0 U	2.3 B
Calcium	--	34200	34500	76800	2700	55300	62500	62200	25000	5680
Chromium	100	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	5.5 U	5.5 U
Cobalt	--	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U
Copper	1,300#	6.9	6.4	8.5	169	4.4 U	28.9	30.3	12.2 B	196
Iron	--	10.2 B	5.7 B	1910	58.3	66.9	37.9	49.8	36.0	387
Lead	15	1.8 B	1.6 B	129	2.0 B	2.0 B	7.3 B	8.6	0.50 UL	1.7 L
Magnesium	--	21900	22400	34200	542	39000	39800	40800	14500	4450
Manganese	--	2.5 B	2.5 B	188	1.2 B	4.2 B	7.0 B	7.1 B	3.5	18.0
Mercury	2	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.11 B	0.09 B
Nickel	100	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.5	6.8
Potassium	--	2140	2100	4970	2410	5260	2200	2380	1840	637
Selenium	50	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 U	0.90 U
Silver	--	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	10.6 K	6.9 U	6.9 U
Sodium	--	6930	6920	33500	7880	89200	29800	32500	3500	5430
Thallium	2	1.9 U	2.2 B	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Vanadium	--	2.0 U	2.0 U	2.0 B	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Zinc	N	5.3 B	5.6 B	83.1	11.8 B	47.4 B	19.0 B	21.1 B	12.2 B	15.0 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-12 SUMMARY OF RESULTS FOR ANALYSIS OF TAL TOTAL METALS IN PRIVATE WELLS (PAGE 3 OF 5)										
Location ID:		**LM-23**		**SA-07**	**LM-20**	**LM-26**	**UM-60**	**UM-61**		**LM-27**
Sample List No.:		53		55, Alt. 1	50	68, Alt. 3	75, Alt. 2	76, Alternate 1		48, Alt. 2
GEC Sample No.:		PW-LM23	PW-LM23D	PW-SA07	PW-LM20	PW-LM26	PW-UM60	PW-UM61	PW-UM61D	PW-LM27
EPA Sample No:		LM23-	LM23D	SA07-	LM20-	LM26-	UM60-	UM61-	UM61D	LM27-
Sample Type:		INV	DUP	INV	INV	INV	INV	INV	DUP	INV
Sample Date:		8/09/93	8/09/93	8/10/93	8/10/93	8/10/93	8/10/93	8/10/93	8/10/93	8/11/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	13.6 U	13.6 U	13.6 U	15.6	13.6 U	13.6 U	13.6 U	13.6 U	13.6 U
Antimony	6	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U	14.1 U
Arsenic	50	1.2 U	1.3	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Barium	2000	34.6	34.6	10.7 B	28.8 B	46.0	42.6	4.5 B	4.8 B	1.4 U
Beryllium	4	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U	0.30 U
Cadmium	5	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U
Calcium	--	67300	66900	9460	48300	31700	47000	23600	25300	682
Chromium	100	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U
Cobalt	--	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U	2.6 U
Copper	1,300#	9.5	12.8	11.4	19.9	27.9	6.6	72.0 J	13.3 J	4.4 U
Iron	--	26.3 B	33.9 J	19.3 B	15.2 B	5.0 B	9.8 B	89.4	56.1	4.9 U
Lead	15	0.5 U	0.5 U	0.50 U	0.50 U	1.4 B	14.0	231 J	25.8 J	1.8 B
Magnesium	--	44100	43900	20900	31800	22300	29900	17500	17900	413
Manganese	--	3.4 B	3.5 B	2.1 B	3.2 B	1.8 B	3.0 B	19.4	19.5	1.2 U
Mercury	2	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Nickel	100	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U	4.3 U
Potassium	--	1670	1690	17100	1790	3450	2470	1680	1760	392
Selenium	50	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL
Silver	--	3.1 U	3.1 U	3.1 U	3.1 U	25.5 K	3.1 U	3.1 U	3.1 U	3.1 U
Sodium	--	32000	32700	118000	8420	5790	11200	4290	4360	99700
Thallium	2	1.9 B	2.0 B	2.0 B	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	2.2 B
Vanadium	--	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Zinc	N	8.4 B	12.3 B	17.1 B	5.6 B	15.2 B	19.4 B	13.1 B	4.9 B	7.0 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-12 SUMMARY OF RESULTS FOR ANALYSIS OF TAL TOTAL METALS IN PRIVATE WELLS (PAGE 2 OF 5)

Location ID:		LE-677		1492	SA-05	0351	LE-1293	UM-40	EM-08	EM-09
Sample List No.:		46		62	60	42	44	71	40	41
GEC Sample No.:		PW-LE677	PW-LE677D	PW-1492	PW-SA05	PW-0351	PW-LE1293	PW-UM40	PW-EMO8	PW-EM09
EPA Sample No:		LE677	LE67D	1492-	SA05-	0351-	1293-	UM40-	EM08-	EM09-
Sample Type:		INV	DUP	INV	INV	INV	INV	INV	INV	INV
Sample Date:		8/05/93	8/05/93	8/05/93	8/05/93	8/05/93	8/05/93	8/04/93	8/09/93	8/09/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	13.6 U	13.6 U	153	15.3 B	13.6 U	13.6 U	13.6 U	13.6 U	13.6 U
Antimony	6	15.5 B	12.4 B	14.1 B	11.2 B	11.0 B	20.7 B	21.8 B	13.4 B	14.1 U
Arsenic	50	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Barium	2000	24.2	21.7	97.0	67.7	22.6	25.1	19.2	22.6	28.2 B
Beryllium	4	0.60 U	0.60 U	0.60 U	0.99 B	0.60 U	0.60 U	0.60 U	0.60 U	0.30 U
Cadmium	5	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.8 U
Calcium	--	38200	35600	15200	10400	35200	43900	40800	65900	53800
Chromium	100	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	3.3 U
Cobalt	--	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.6 U
Copper	1,300#	6.2 U	6.2 U	32.9	8	6.2 U	6.2 U	10.5	11.9	18.9
Iron	--	19.3	32.3	775	1630	16.7	15.3	66.2	23.2	107
Lead	15	1.3	1.9	0.65	1.6	2.1	0.50 U	0.50 U	0.50 U	0.79 B
Magnesium	--	21300	20000	9600	4550	19600	25100	27600	31900	29000
Manganese	--	5.2	3.4	11.6	281	8.7	5.8	9.7	11.2	9.2 B
Mercury	2	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Nickel	100	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	4.3 U
Potassium	--	1970	1840	1550	1370	1820	2120	2190	2310	2380
Selenium	50	0.90 U	0.90 U	0.90 U	0.90 U	0.90 UL	0.90 UL	0.90 UL	0.90 UL	0.90 UL
Silver	--	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	3.1 U
Sodium	--	6000	5470	9470	15300	5520	4310	3090	12100	12400
Thallium	2	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 B	1.9 U	1.9 B
Vanadium	--	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	2.0 U
Zinc	N	60.2 J	83.6 J	12.0	36.0	365	20.8	6.6	25.1	11.8 B
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

TABLE 3-12 SUMMARY OF RESULTS FOR ANALYSIS OF TAL TOTAL METALS IN PRIVATE WELLS (PAGE 1 OF 5)

Location ID:		UM-43	UM-58		1501	LM-10	LE-311	UM-45		UM-59
Sample List No.:		72	79		63	47	39	73		74, Alt. 1
GEC Sample No.:		PW-UM43	PW-UM58	PW-UM58D	PW-1501	PW-LM10	PW-LE311	PW-UM45	PW-UM45D	PW-UM59
EPA Sample No:		UM43-	UM58-	UM58D	1501-	LM10-	LE311	UM49-	UM49D	UM59-
Sample Type:		INV	INV	DUP	INV	INV	INV	INV	DUP	INV
Sample Date:		8/03/93	8/03/93	8/03/93	8/03/93	8/03/93	8/04/93	8/04/93	8/04/93	8/04/93
Compounds:	**MCL (ppb):**	**CONCENTRATION (µg/l or ppb)**								
Aluminum	N	13.6 U	13.6 U	13.6 U	14.1 B	13.6 U	13.6 U	13.6 U	13.6 U	13.6 U
Antimony	6	13.3 B	12.4 B	9.2 U	11.2 B	14.6 B	9.2 U	9.2 U	20.5 B	9.7 B
Arsenic	50	1.6	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U
Barium	2000	169	27.6	29.3	9.2 B	26.8	217	6.7 B	6.7 B	36.0
Beryllium	4	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
Cadmium	5	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
Calcium	--	41000	46000	46400	10100	30300	17700	25400	25100	33200
Chromium	100	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U	5.5 U
Cobalt	--	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U
Copper	1,300#	6.2 U	12.7	8.7	137	17.2	75.1	6.4	6.2 U	41.7
Iron	--	307	15.3	14.6	112	38.1	165	15.9	13.0	36.6
Lead	15	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	2.6	0.50 U	0.50 U	0.53
Magnesium	--	13000	26300	26500	7900	18500	8440	16900	16700	19400
Manganese	--	37.4	3.4	5.3	25.5	4.4	78.9	13.8	12.2	3.5
Mercury	2	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
Nickel	100	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	8.1	4.4 U	4.4 U	4.4 U
Potassium	--	2910	2660	2580	1620	2110	4510	1880	1850	1850
Selenium	50	2.0 L	1.10 L	0.90 UL	1.10	0.97	0.90 U	0.90 U	0.90 U	2.1
Silver	--	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U	6.9 U
Sodium	--	8740	20900	21000	9530	5920	10500	4100	3990	5100
Thallium	2	3.8 B	4.0 B	4.5 B	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Vanadium	--	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U	3.7 U
Zinc	N	6.5 U	34.5	34.5	16.4	9.1	4870	9.9	11.8	14.9
Cyanide	200	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U

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- Section 6 - Summary and Conclusions, which summarizes the key findings and conclusions of the RI activities related to the site.

1.3 Site Background and Physical Setting

The following section presents relevant information regarding the history and physical setting of the site and vicinity.

1.3.1 Site Location and Description

The site is located at Sixth and Minor Streets in the Borough of Emmaus, Lehigh County, Pennsylvania, about 5 miles south of the City of Allentown, as shown on Figure 1. The approximate site geographic coordinates are Latitude 40° 31' 53" N, Longitude 75° 29' 37"W. The site is bordered by Minor Street to the north, Sixth Street to the west, an alleyway to the east, and the Perkiomen railroad line to the south. Land use in the area surrounding the Rodale site includes residential as well as industrial and commercial facilities.

1.3.2 Site History

This section presents a brief summary of historical site operations and general environmental information. Unless otherwise noted, this information was obtained from sources referenced in the report "Site History and Laboratory Results for the Rodale Manufacturing Site" (GEC, October 1991). Further details regarding the previous investigation activities identified below are presented in Section 2.0 of this report.

The site property had been used for commercial or manufacturing purposes since at least the 1920s. Prior to the 1930s, the site was occupied by the D.G. Dery Silk Corporation and later by Amalgamated Silk Corporation. According to annual versions of the Pennsylvania Industrial Directory, Rodale Press, a publishing and printing business, occupied portions of the building from at least 1938 until 1959 (Pennsylvania Department of Health, 1991). From the late 1950s until 1975, the site was operated by Rodale Manufacturing to make wiring devices and electrical connectors. The manufacturing process included various electroplating techniques. In 1975, the site was sold to Bell Electric, a wholly-owned subsidiary of Square D, which manufactured similar electrical components. In 1986, Square D closed manufacturing operations at the site. Buildings at the site were partially demolished in

1989; the remaining portions were demolished in 1993. Previously-used waste disposal wells were identified during demolition activities.

Activities under Rodale Operation of Facility

Specific operational practices prior to 1961 are largely unknown. Pennsylvania Department of Environmental Protection (PADEP) files indicate that under Rodale Manufacturing's operation of the facility, several wells were used for disposal of various wastes. PADEP files indicated that in 1962, approximately 3,000 gallons per day (gpd) of wastewater, including rinse water from copper and zinc plating and acid brass dipping, were discharged to a 452-foot deep borehole (subsequently identified as Well 1) located in the former Courtyard Area (Figure 2). Borough of Emmaus files indicate that the electroplating room was connected to the sanitary sewer by January 1967. Rodale's operation continued until 1975 when the business was sold to Bell Electric (a subsidiary of Square D).

Activities under Square D Operation of Facility

Past disposal practices were first identified by Square D in March 1981, when a capped borehole (Well 1) was discovered during the installation of new equipment. Long-time employees of Rodale Manufacturing indicated that two other wells (Well 2 and Well 3) were also used for disposal purposes, and the locations of these wells were identified. From June to September 1981, Square D arranged for liquid wastes and some impacted ground water to be removed from Wells 1, 2, and 3, and disposed of by licensed haulers at licensed disposal facilities. A monitoring well (Well 4) was installed to a depth of 342 feet below ground surface (bgs) in June 1981 by Gill Enterprises on behalf of Square D. Water samples collected from the monitoring well and the three identified disposal wells revealed the presence of varying concentrations of volatile organic compounds (VOCs), metals, and cyanide.

In addition to the three disposal wells (Wells 1, 2, and 3), two additional wells (Wells 5 and 6) were also identified by Square D at the site in the early 1980s. Well 5, a shallow cistern, was discovered in late 1981. Well 6, located at the west end of the courtyard, was apparently used for makeup cooling water and not for disposal purposes.

In 1984, operation of an air-stripping tower commenced for removal of VOCs from ground water pumped from Well 1. A National Pollutant Discharge Elimination System (NPDES) permit for surface discharge of treated ground water was issued by the PADEP. The pumping and air-stripping activities continued until 1989 when

Square D proceeded with demolition of Building D and discontinued operation of the interim ground-water pumping and air stripping program. Ground-water monitoring results obtained between 1981 and 1988 indicated that the pumping and air-stripping activities were effective in lowering VOC concentrations in Well 1 from hundreds of parts per million (ppm) to less than 1 ppm (SNR Company [SNR], 1989).

Following closure of the facility by Square D in 1986, investigative and remedial activities continued. In 1988, Square D retained SNR of Laguna Hills, California to prepare a Ground Water Monitoring Plan. In preparation of this plan, SNR installed four ground-water monitoring wells (originally designated SW-A through SW-D but now referred to as MW-1 through MW-4) around the perimeter of the facility. The wells were screened near the water table. In 1989, the south wing (Building D) was demolished to provide space for additional remedial activities. During demolition, a well (designated WW-08, 6 feet in diameter and approximately 55 feet in depth) was discovered. Two fuel oil underground storage tanks (USTs) were also removed (Figure 2). Further details regarding the ground-water investigation activities implemented by SNR are presented in Section 2.1 of this report.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Response Action and Subsequent Activities

In January 1989, NUS Corporation conducted a Site Inspection (SI) on behalf of the USEPA at the site. The SI consisted of the collection of water samples from the three former on-site disposal wells, four on-site monitoring wells, three of the six Borough of Emmaus water supply wells, and three residential wells. The results of the SI are discussed briefly in Section 2.2. In November 1989, the PADEP collected several water samples from wells located downgradient of the study area, including one Borough of Emmaus water supply well (PSW-7) and five downgradient private wells in Lower Macungie Township. The results of this sampling event are discussed in Section 2.3. An additional hydrogeologic investigation was completed by Roy F. Weston, Inc. (Weston) during 1989. The activities performed and results associated with this investigation are discussed in Section 2.4. In 1990, a monitoring/recovery well (RW-1)was installed at the site and another monitoring/recovery well (RW-2) was partially completed with the installation of surface casing. Final completion was to be based on the anticipated use of the well. The locations of all known disposal, production, recovery, and monitoring wells at the site are indicated on Figure 2. Table 1-1 presents summary information regarding well construction details, dates of installation, and a description of Wells 1 through 7, WW-08, RW-2, and for RW-3; while Table 1-2 presents a summary of the information regarding monitoring wells MW-1 through MW-4.

On July 29, 1991, following the Hazard Ranking System review process by the USEPA, the site was proposed for placement on the National Priorities List (NPL). An AOC to conduct the RI/FS was subsequently executed between the USEPA and Square D (effective September 21, 1992).

In 1993, GEC, a consultant to Square D, supervised the demolition of the remaining portion of the buildings. During demolition, two additional site features were identified:

- Well 7, which is believed to have been used for septic disposal; and
- Tank-1, which is a closed-bottom cistern possibly used for fuel oil storage.

The locations of both features are illustrated on Figure 2.

GEC implemented two additional phases of investigation, which were reported in the Well Survey Evaluation Report (GEC, September 1993) and the Time-Critical Investigation Report (GEC, October 1995). The activities performed and the results of these investigations are discussed in Sections 2.5 and 2.6, respectively.

A separate AOC for Removal Response Action (RRA) (USEPA Docket No. 111-94-15-DC) for a site ground-water treatment system (GWTS) and related tasks was also executed between the USEPA and Square D, effective September 30, 1994. The document entitled "Supplement I to the Time-Critical Work Plan for the Rodale Manufacturing Site," which includes a conceptual design for the ground-water pump-and-treat system was prepared and submitted to the USEPA (GEC, February 28, 1995) pursuant to this AOC. Supplement I also included a presentation of site conditions, an evaluation and screening of treatment technologies, and the conceptual design of the subsequently constructed ground-water pump-and-treat system. These Non-Time Critical Interim Response Action activities are further discussed in Section 2.7.

1.3.3 Physical Setting

Prior to final demolition in 1993, the site consisted of a three-story building that occupied most of the site (designated as three inter-connected sections: Buildings A, B, and C) which served as a manufacturing, warehouse, and office facility on a parcel of property. An exterior, open-space courtyard area existed on the south side of the facility. This open area was expanded in 1989 as a result of an earlier demolition of the southern wing of Building

D. The disposal wells (Wells 1, 2, and 3) were located in the open area, along with several other wells and cisterns (Figure 2). Final demolition activities, overseen by GEC, were conducted at the site from August to December 1993.

Following demolition in 1993, the site was graded with quarry fill and #2A modified stone. The basement under Building A, which measured approximately 170 feet in length (north-south direction) by 50 feet in width (east-west direction), was backfilled with clean quarry fill prior to the final grade-level application of #2A modified stone. The fill materials were certified as clean based on laboratory analyses. The walls were left in place, and the floor of the basement broken up prior to backfilling to allow for proper drainage.

Currently the only remaining on-site structures are the ground-water treatment system (GWTS) building and recovery well protective enclosures. Water is supplied by a 2-inch water service connection to two fire hydrants on the north side of the site. A storm water catch basin near the southwest corner is connected to the storm sewer along Sixth Street. The site is bounded by a 6-foot high chain-link security fence on the south property line, and an 8-foot high red cedar security fence on the north, east, and west sides. The site is accessible through locking gates on the east and west sides of the site.

1.3.3.1 General

Topography

Topography in the Borough of Emmaus varies from between 350 feet and 500 feet above mean sea level (AMSL). The most prominent topographic feature in the vicinity of the site is South Mountain to the south and southeast with gently sloping hills and stream valleys to the west, north, and northwest. The peaks of South Mountain extend as high as 1,000 feet AMSL. Topographic features in the vicinity of the site include: the Lehigh River; Leibert, Little Lehigh, Swabia, and Cedar Creeks; Chestnut Hill; Lock Ridge; and Bauer Rock. Elevations across the 1.2-acre site range from 460 to 470 feet AMSL, with the lowest point located within the central portion of the northern half of the site.

Given the observed site topography and the fact that the entire site surface is covered with crushed stone, 100 percent of the precipitation to the site would be expected to infiltrate into the subsurface during most rain events, and no significant runoff would be anticipated from the site.

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6. Summary and Conclusions

The following summary statements and conclusions may be drawn from the available information generated through this RI and previous investigations.

- The sequence of unconsolidated materials forming the subsurface at the site vicinity includes a soil loam layer underlain by a thick sequence (i.e., up to 250 feet) of saprolite (highly weathered bedrock). The near-surface materials encountered at the site consist of between 3 and 15 feet of fill capped by one to three feet of crushed stone.

- Observations from the boreholes completed in connection with the RI indicate the saprolite appears to be slightly metamorphosed (phyllitic) and varies in thickness from approximately 50 feet to more than 250 feet in the site vicinity.

- The first bedrock unit encountered in the immediate site vicinity consists of the Paleozoic Leithsville Formation locally composed predominantly of gray to yellowish buff, fine-grained, thin bedded dolomites that grade locally into massive beds of blue gray dolomite interbedded with various thicknesses of calcareous shale.

- The bedrock in the site vicinity was observed to be highly fractured and faulted, with the predominant fracture orientations aligned generally in a north-northeast/south-southwest direction, and faults trending northwest-southeast.

- The hydraulic gradients observed in the site vicinity indicate the horizontal component of ground-water flow is generally toward the north-northwest, in the direction of Little Lehigh Creek. This is consistent with the conceptual site model and literature citations which suggest that ground-water migrating through the subsurface in the site vicinity would discharge to Little Lehigh Creek.

- A linear ground-water depression has been consistently observed on the potentiometric contour maps prepared for both the shallow and deeper bedrock extending from an area immediately west of the site toward the north-northwest. This feature appears to be acting as a preferential pathway for the migration of ground water and may be related to northwest trending dissolution enhanced fault feature. This feature is consistent with a similar feature interpreted in the same area by the USGS.

- Transmissivity of the bedrock aquifer was estimated from the on-site pumping tests performed by SNR (1989) and recently during the RI range from 500 gpd/ft to 9,000 gpd/ft. Estimates of transmissivity calculated through reduction of the specific capacity tests of selected depth intervals of the bedrock aquifer indicate a wider range of values from 60 gallons per day per foot (gpd/ft) to 120,000 gpd/ft. Similarly, estimates of hydraulic conductivity based on the specific capacity tests vary from 9.5×10^{-5} cm/sec to 1.4×10^{-1} cm/sec. The hydraulic conductivities estimated from the on-site pumping tests range from 1.18×10^{-5} cm/sec to 4.77×10^{-3} cm/sec.

- The bedrock at the site has been characterized in terms of primary porosity (mean matrix porosity of 0.065) and secondary porosity (mean fracture porosity of 0.0016). Secondary porosity features (fractures) have been characterized based on bedrock core samples, and downhole fracture spacing and orientation measurements. These methods both indicate that the bedrock is highly fractured along two main orientations. The mean fracture spacing has been measured as 0.86 feet.

- Historical operations at the site are known to have included the use of several bedrock wells, ranging in depth from approximately 250 feet to 450 feet, for the disposal of wastewater, including electroplating constituents, hydraulic oils, and TCE and other solvents at the site.

- Ambient air sampling results obtained during the RI identified only a single compound (toluene) at concentrations ranging from 2.4 to 3.7 ppb v/v. These results were consistent from upwind to downwind locations and do not appear to be site-related. Therefore, the results of the RI confirm the lack of environmental risk associated with air exposures at the site.

- Surface soil sampling results indicated no concentrations above their respective PA Interim Cleanup Standards. Furthermore, no incidental direct contact risk is present due to these soils being covered with a layer of gravel and the relatively low concentrations present.

- Subsurface soil sampling results indicate the presence of TCE and other constituents at concentrations above the PA Act 2 Standards. Of the 16 VOC exceedances observed, 14 of these exceedances occurred between the depths of 40 feet and 90 feet within soil borings which are situated in the immediate vicinity of Injection/Disposal Well 2 (Figure 39). These results demonstrate that the extent of impacts to the subsurface soil are limited to a small area within the center of the site.

- Dissolved TCE concentrations were observed to exceed 1 percent of TCE's single-component solubility (1 percent of 1,100,000 ug/L = 11,000 ug/L) in six of the on-site wells including RW-3 (490,000 ug/L), Well 2 (420,000 ug/L), Well 4 (140,000 ug/L), Well 3 (100,000 ug/L), MW-4 (45,000 ug/L), and MW-1 (17,000 ug/L). Dissolved TCE concentrations in excess of 1% of this compounds solubility demonstrate the presence of DNAPL in the immediate vicinity of these wells and support the use of a front-end TI Evaluation of ground-water restoration for this site.

- Dissolved TCE concentrations observed in the ground-water samples from the off-site monitoring wells were all at or below the USEPA MCL of 5 ug/L, with the exception of the samples from the shallow and deep wells at the MW-9 cluster, which contained 22 ug/L and 1,000 ug/L, respectively (Figure 40). However, the dissolved constituents observed in the monitoring wells at the MW-9 monitoring well cluster do not appear to be related to the site, given the fact that the hydraulic head in these wells has been observed to be consistently higher than the hydraulic head at the site. A separate source of VOCS in ground water unrelated to the site is evident based on this observation.

- The observation of dissolved constituents in ground water at Public Supply Well locations hydraulically upgradient or far enough sidegradient from the site (i.e., PSW-1, PSW-2, PSW-3, and PSW-4) demonstrate the existence of separate sources of dissolved constituents to the ground water in proximity to the public supply well (Figure 5) unrelated to the Rodale site . A number of facilities were identified through a previous investigation (Weston, 1989) in the general vicinity of the site which may be contributing dissolved constituents to the ground-water.

- The results of the off-site ground-water sampling of private wells performed in connection with the Well Survey Evaluation (GEC, 1993), identified only two samples (PW-LM20 and PW-SA08Dup) and one spring sample (SP-03) in which any VOC was observed above relevant regulatory criteria. However, trace concentrations of VOCs were detected in numerous private wells located upgradient or sidegradient from the site. This further supports the existence of other sources of dissolved constituents to ground water in this vicinity.